Incorporating "The Illuminating Engineer."

Light and Lighting

Official Journal of the Illuminating Engineering Society.

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Principal Contents:

PAGE

Editorial Notes.... 121

Notes and News 122

Street Lighting and Traffic Accidents 124

Lighting in Factories (Fifth Departmental Report) 125

Lighting Literature 128

A Flashing Lamp of Simple Design.... 132

Where to Buy 135

Factory Lighting in War Time

THE anxiously awaited Fifth Report of the Departmental Committee on Lighting in Factories and Workshops has appeared (see pp. 125).

The recommendation that will excite most attention is that prescribing, with certain exceptions, a general illumination of 6 foot-candles — a notable advance upon the 1 foot-candle, figuring in the Fourth Report of only two years ago!

This increase is regarded as justified by the exceptional conditions under which workers are now labouring — the prevalence of night work and overtime, coupled with the inevitable exclusion of daylight in order to comply with black-out conditions. The new value is in effect a working illumination, though higher figures, as specified in the I.E.S. "Recommended Values," will often be necessary.

The Committee, however, places as much emphasis on "suitability" as on "adequacy." In particular, the depressing effect of workrooms from which natural light is completely excluded is noted. Nothing can adequately replace the light of day. Black-out methods should be so devised as to permit the entry of a substantial amount of daylight, uniformly distributed over the working area.

Illuminating Engineering Society in South Australia

Some little time ago we referred to the proposal to form an Illuminating Engineering Society in South Australia. The new society has now been formed and takes its place with the established societies of New South Wales and Victoria. Its advent* brings closer the objective of a National Illuminating Engineering Society of Australia, which has for some years been the subject of negotiations between the older societies. The new society starts with good prospects. Its first president is Professor Kerr Grant, of Adelaide University, and its vice-presidents comprise an engineer of standing (Mr. A. N. Dawkins) and a leading architect (Mr. Dean W. Berry). The Council appears to be of a representative nature. At the inaugural meeting an address was given by the president of the Illuminating Engineering Society for Victoria (Mr. L. D. Wright), and a membership roll of about fifty resulted. In the meantime, the societies in Victoria and New South Wales have both been making good progress. The latter recently completed for the authorities a comprehensive report on war lighting restrictions.

War-time Street Lighting

It will not be long now before the dark nights are again upon us—perhaps to be endured under more hazardous conditions than last winter. We are glad to hear reports of good progress towards the installation of war-time street lighting. Local authorities who have not yet taken steps should delay no longer. Delivery will doubtless become more difficult as autumn approaches. We hope, too, that wherever possible the installation will be on a fair scale. Experience in large cities has shown how much better is the effect when an extensive area is covered. It is perhaps not so easy to explain quite why this should be so. Possibly the fixation of the adaptation of the eye to a definite level, which is preserved as one moves about in an area of uniform brightness, is one material factor. The permissible value (0.0002 ft.c.) is certainly a very low one. All the more reason, therefore, to make the very best use of the lamps available and to site them in the right positions. Indifference to this factor may easily lead to very much lower values of illumination. Still another vital point, at these low illuminations, is *contrast*, such as may be secured by the judicious use of white paint, more particularly on vertical surfaces.

*I.E.S. Lighting Review (Australia), Apr., 1940.

Make the Public Understand

Although, largely owing to the joint efforts of the Illuminating Engineering Society and the Association of Public Lighting Engineers, the nature of this war-time street lighting was very fully explained and featured in the Press last winter, there are still, on the one hand, those who speak of it as too faint to be of value and, on the other, those who (with much greater perversity) imagine that it is a source of danger from enemy aircraft. During an air raid the value of this weak illumination, as compared with total obscurity, is inestimable. Yet, owing to the care expended on the design of these standard fittings, there is no danger of their being themselves visible from above or of the faint illumination they afford being evident to hostile aircraft. We recall this because of the report that during recent air raids stones were thrown at certain fittings—action not only misguided but a punishable offence. There seems a need to make it clear to the public that these lights are innocuous and that the whole purpose of their design has been to enable them to be kept on permanently, even whilst raids are in progress. Approved installations of other somewhat higher values (e.g., 0.002 ft.c.) sanctioned for essential work in the neighbourhood of works and railways are also occasionally made the basis of public complaint, with the result that time is needlessly wasted. Another, though now less frequent, form of "frivolous complaint" is that relating to alleged infringements of the black-out—when a faint light can be seen pentrating through a chink *downwards*, but is nevertheless quite invisible from above. There does seem a need for a little public instruction on such points. Is this, perhaps, a service which the Ministry of Information might render?

I.E.S. Fellowship

Concession to Country Members.

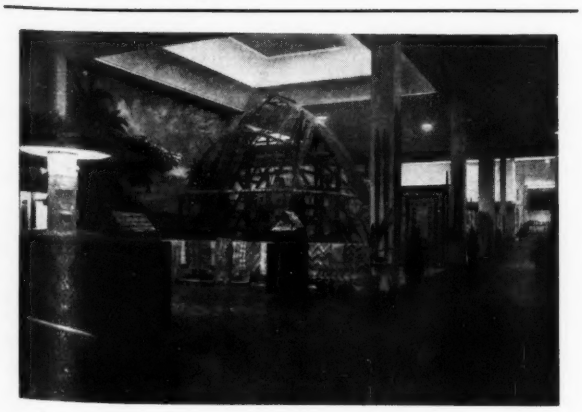
The attention of I.E.S. country members is drawn to the concession announced in TRANSACTIONS (July, 1940, p. 88) on the lines indicated in our last number.

In the case of country members of two years' standing or more a transfer to Corporate Membership may be considered to date from a period two years prior to the date of application on his behalf for Fellowship, provided that any additional subscription involved is duly paid to the society. The arrangement will continue in force for the present year (1940) only.

Artificial Skylights

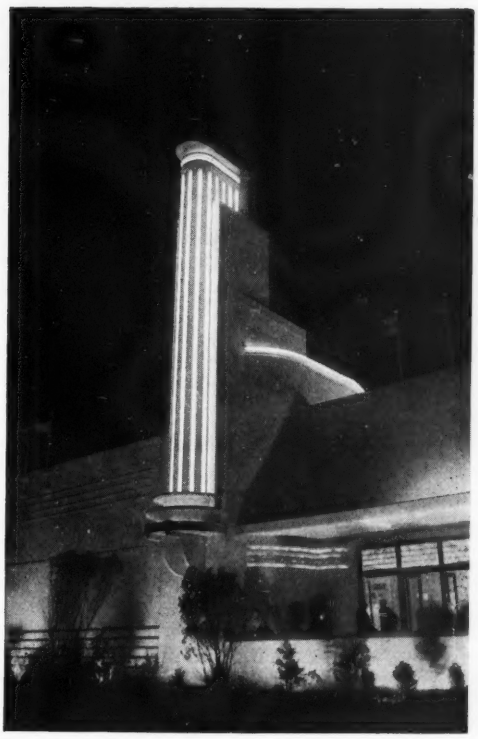
The use of "artificial skylights" in a foundry, illustrated in our last issue (July, 1940, p. 111), has attracted interest. It has been pointed out that the advantage of such an arrangement in a black-out factory, of relieving the overhead gloom caused by the exclusion of daylight, is only one of its merits. At least equally important is its function of providing large areas of mild brightness which are often of great benefit in the inspection of polished surfaces. This effect is often mentioned as a somewhat specialised problem in industrial lighting, associated with certain specific processes (such as the examination of tin sheets), but it enters into ordinary visual operations to a much greater extent than is commonly imagined. An instructive case brought to our notice was that of an office occasionally used for draughtsmanship. Although relatively deep this office, situated high up, was well lighted by windows occupying practically the entire wall facing the street. The natural lighting for over three-quarters of the room was usually fully adequate, but artificial light (from a semi-indirect unit under a white ceiling) was occasionally necessary in the part of the room most remote from the window. It had been observed, however, that workers in the centre of the room were inclined to turn on the artificial light at times when it was apparently quite unnecessary. Investigation revealed that this was due solely to difficulty in making out engraved figures on a steel or brass background—more especially protractors, necessarily laid on the horizontal drawing and dependent on reflection of light from above. The small figures could be seen with ease when a reflected image of the illuminated ceiling was obtained, but they were most difficult to make out by the aid of the high daylight illumination received at an oblique angle from the window.

The effect is more or less in evidence whenever operators are at work on polished material, and explains in some degree the persistent preference for local adjustable lights which the worker can manipulate so as to get the precise reflection he requires. If the stationary overhead units are sufficiently extensive, or if a well-lighted ceiling is available, this should go far towards satisfying the worker's needs in this respect, though there remains the traditional affection for a source of light under personal control, chiefly characteristic of the older workers. Hand work on metals is not infrequently done on benches round the edge of a workroom, the centre of which is occupied by machinery. One can readily understand the demand for full access of daylight at these benches. This, no doubt, explains why one so often sees the upper parts of windows permanently blacked out and the lower areas left free during the daytime, though, theoretically, it is the upper portions of the windows which are most valuable for admission of daylight.



Traditional Maori work illuminated by electric discharge tubing in three colours.

The New Zealand Centennial Exhibition



Showing the fluted columns marking the main entrances illuminated with fluorescent tubing and colour-changing troughs.

The New Zealand Centennial Exhibition was a highly enterprising effort, especially bearing in mind the remote geographical position and relative small population of this, the youngest, Dominion. Success in this instance depended primarily on inducing visitors to return again and again, not on the distance from which they could be attracted. Hence the importance of the illuminations, which were provided over an area of about sixty acres, including sixteen acres of buildings. A total power of 1,000 kw. was available.

It was decided to adopt mass-colour treatment of the building frontages, with animation at selected points and a panorama with very slow colour-changing cycles at positions of major importance. Totally indirect lighting was prescribed except for fluorescent discharge tubing effects and certain exposed lamps of low wattage. The chief buildings were placed along broad avenues in the form of a cross whose stem was the main "Centennial Avenue," leading from the entrance gates to the "Centennial Tower," 160 ft. high, which dominated the three vertical lines of neon tubing, with amber flood-lighting for the sides. Colour changing effects were skilfully applied in connection with the entrances and elsewhere, and the fluted columns (illustrated above) had a striking effect. The general lighting of the avenues and gardens was carried out by single pylons 25-30 ft. high and furnishing indirect lighting. About 500 kw. was handled by the dimmers controlling the colour lighting.

An ingenious device was the automaton "Dr. Welland Strong," composed of papier mâché and operated by machinery below the floor, which moved about in the Health Department describing the exhibits and pointing out their main features. Sound and movement were photoelectrically synchronised. When the doctor said "Shall we move on," he suited the action to the word.

The contract for this large lighting scheme was placed with the British General Electric Company, Ltd., of Wellington (N.Z.).

Street Lighting and Traffic Accidents

The Study of the "Night/Day" Accident Ratio and the Application of Local Analysis to Highway Lighting

In Great Britain and in other countries affected by the black-out conditions in regard to traffic accidents are naturally abnormal. In the period immediately after the black-out was introduced the great rise in night accidents gave ground for concern. Subsequently some degree of diminution suggests that the public are becoming more accustomed to the new conditions. During the present summer months, with relatively light nights, accidents seem to have been much less frequent, but the figures may again become formidable when the winter sets in.

The Night Accidents/Day Accidents Ratio.

A feature of certain figures quoted for the autumn of 1939 was the fact that, for the first time, the proportion of accidents occurring by night was definitely far greater than by daylight.

In discussing the informative report on the road accidents issued by the National Safety First Association in 1933, it was pointed out how the proportion of accidents occurring at night has steadily risen from 17 per cent. of the total in 1913 to 29 per cent. in 1920 and 46 per cent. in 1926. The average figure deduced from the 1933 data was 54 per cent., so that at that time the equality line between night and day accidents had just been passed, and the ratio of the number of night accidents to the number of day accidents had become slightly over 1 : 1. This steady change in the proportion was, of course, not due to a progressive deterioration in lighting conditions in the streets but to the familiar fact that the roads are being used to an ever increasing extent by night.

In determining and comparing such ratios it is essential that the full period of one year should be taken, or that the variation in the hours of darkness should be taken into account by some means (e.g., by comparing the average number of accidents per hour instead of the aggregate).

Allusion has been made above to some remarkable figures recorded for London during the initial period of the black-out.* The proportion of night accidents was nearly 80 per cent. of the whole, and the ratio of night accidents to day accidents, therefore, approximately 5 : 1—a complete revision from the 1 : 6 ratio recorded for 1913, but an obviously abnormal figure due mainly, no doubt, to the difficulties imposed by an almost complete absence of artificial light, but also to the fact that only the dark winter months were considered. During the month of June (when the longest days occur), 1940, the total road fatalities (479) were, it is stated, slightly less than for June, 1939. Only 92 of these deaths occurred in the black-out, giving a night/day ratio of approximately 1 : 4 only.

It is, however, of interest to note that the tendency under normal conditions is still in the same direction. In an instructive analysis of road accidents in Los Angeles, Mr. Melvin J. Bankhead† has recorded that of all reported accidents 55 per cent., and of fatal accidents 61.5 per cent., occurred at night —a proportion somewhat above the 1933 figure for this country. If pedestrians only are considered the figure, 69 per cent., becomes definitely higher.

There has been a considerable amount of argument in regard to the interpretation of numbers of "day" and "night" accidents. Broadly speaking—considering the relatively less motor traffic, the comparative absence of pedestrians on the road during most of the night, and the fact that in the "wee small hours" the roads are, even to-day, little used—a ratio of equality between numbers of night and day accidents indicates that deficiency in illumination by night must be an important factor. Confirmatory evidence is afforded by a comparison of records for certain hours, rush hours in the early evening, which are light in summer, but dark in the winter time. Yet the number of extraneous factors is so great that it is difficult to draw definite conclusions from masses of statistics. Even if such factors as variations in the flow of traffic, weather conditions, and state of the road surface can be eliminated, there remains the difficulty that a certain tendency in one part of a large area may be compensated by an opposite tendency in another.

This lends interest to the methods of analysis being adopted in Los Angeles, which are based less on wholesale statistics than the careful study of certain limited areas, specific highways or particular locations.

If this is done apparent anomalies can often be explained. It is evident, for example, that accidents on a road may be few merely because the lighting is so bad that few drivers will use it. The first effect of improving the lighting may be to increase the volume of traffic which may well lead to an actual increase in accidents—though not in the number of accidents for a given traffic flow. There is, however, a more subtle danger—that greatly improved lighting leads to higher speeds, apparently safe to many users, and yet dangerous at certain times. In effect a sense of false security is created. This is not an argument against better lighting, but it does show the need for other corrective devices. The existence of a high night/day accident ratio does not necessarily mean that improved lighting throughout the entire length of a highway, perhaps an expensive project, is necessary. Much can be done by improving the lighting at certain points of extreme night hazard. An example of this kind, now being studied, is the new Ridge Route in the Los Angeles district, where an accident record of thirty-four by night and eleven by day—a ratio of almost exactly 3:1—has been noted.

Whilst it is often difficult to prove that better lighting over a large area has diminished accidents, it is often possible to draw a definite conclusion when attention is concentrated on some dangerous spot. If the number of accidents by night is *very much greater* than that occurring by day it may usually be inferred with confidence that there is something wrong with the lighting or the arrangements of traffic signals. Thus Mr. Bankhead records that at a certain road intersection four accidents, all occurring after dark and resulting in nine injuries and one death, took place during the first nine months of 1939. The introduction of a centrally suspended 10,000 lumen sodium unit has apparently solved the problem. During the subsequent six months no accidents have occurred.

Another instructive case was afforded by the intersection of a major state highway and a major county highway. During 1937 twenty-five reportable accidents, resulting in one death and forty-seven injuries, occurred at this spot. Investigation showed that twenty-four out of twenty-five occurred during darkness. Eventually two remedial measures were taken—the provision of extra illumination from a centrally suspended 10,000 lumen sodium lamp at the intersection, and the installation of an advance stop sign 400 feet ahead of the intersection. During a subsequent 15½ months only two accidents, resulting in six injuries to people, have been reported.

It is expected that the detailed analysis now being undertaken will reveal other places where the accident rate is above the general level for the district. If a high night to day ratio exists some lack of visibility may be inferred, and the cure for this will depend upon the exact circumstances revealed. The essential point is to undertake an analysis which makes it possible to deduce the correct remedies.

* Light and Lighting, February, 1940, p. 20.
† Illuminating Engineering (U.S.A.), June, 1940, p. 514.

Lighting in Factories*

Fifth Report of the Departmental Committee

In what follows we give a summary of the above Report, issued just before the commencement of the present month, which is of outstanding importance. The Chairman of the Committee is Sir Duncan Wilson and the Secretary Mr. R. W. Daniel. The other members whose signatures are attached to the Report are:—Brigadier-General A. C. Bayley, Mr. John S. Dow, Miss Florence Hancock, Sir John H. Parsons, Mr. W. Scholes, Mr. Geo. W. Thomson, Dr. J. W. T. Walsh, and Mr. H. C. Weston.

Introduction.

In September, 1938, the Fourth Report of the Departmental Committee on Lighting in Factories and Workshops was issued. Up to the outbreak of war regulations embodying these recommendations had not been made, and modification was then felt to be necessary. The position was reviewed in the light of war conditions, evidence was taken and visits to representative factories were made.

Statements were received from the Ministry of Supply, the Air Ministry, and the Factory Inspectorate, also from the Illuminating Engineering Society, the Electric Lamp Manufacturers' Association and allied bodies, and the Institution of Gas Engineers.

Following the outbreak of war devices to restrict the emission of light during hours of darkness were hastily improvised. The general application of black paint or other opaque material to windows, completely eliminating natural light during the day and resulting in inadequate ventilation, led to conditions that were often unsatisfactory and sometimes intolerable. Later there has been an increasing tendency to make use of shutters and blinds permitting the admission of natural light during the day. At the present time three conditions are recognised: (1) Factories where no night work is done and obscuring materials have been entirely removed; (2) factories still permanently obscured owing to difficulties associated with camouflage design or to special structural features, and (3) the majority of factories in which provision for the admission of some natural light is made. At the present time in many factories work has to be done at high pressure, imposing greater strain on the worker. Also, owing to the prevalence of night work and overtime, the time spent under artificial light is much longer—sometimes 50-100 per cent., as compared with 10-15 per cent. in pre-war days.

The Committee state that they have been unable to find evidence that prolonged or even continuous work under artificial light has any deleterious effects upon health and safety. But the present conditions are regarded as unnatural and new to the majority of workers. The maintenance of a higher standard of lighting than that previously recommended is therefore considered justified in the interests both of the workers and of increased production.

Recommendations.

In view of the above circumstances the Committee makes the following recommendations in regard to Adequacy of Artificial Lighting:—

ADEQUACY.

(1) *In respect of interior work places.*

(1) Over the interior parts in which persons are regularly employed the illumination shall not be less than 6 ft.c. without prejudice to any additional illumination required by the nature of the work.

Provided that in parts of factories where persons are employed, in which the mounting height of the light sources necessarily exceeds 25 feet measured from the floor, or where the structure of the room prevents the uniform provision of this standard, the illumination shall not be less than 2 ft.c., and not less than 6 ft.c. where actual work is being done, without prejudice to any additional illumination required by the nature of the work.

The illumination shall be measured in the horizontal plane at a level of 3 feet from the floor.

These standards are inapplicable to certain factories, such as some departments of glass works and of works manufacturing photographic material. Other instances where relaxation is justified include electrical generating stations and other places, where work consists mainly in watching and reading dials and other instruments locally illuminated. It may, therefore, also be necessary to give the Chief Inspector power to grant exemption in special cases.

In respect of interior passage and access.

The Committee adheres to the standard previously suggested and accordingly recommends that:

(2) Over all interior parts over which persons employed are liable to pass other than those in which persons are regularly employed, the illumination at floor level shall not be less than 0.5 ft.c.

In respect of exterior employment passage and access.

It is explained that the previous recommendation (specifying a min. illumination of 0.1 ft.c.) is now inapplicable owing to the Lighting (Restrictions) Order. Considerable aid to movement can, however, be afforded by the provision of the permissible minimum street lighting standard of 0.0002 ft.c., combined with the whitening of kerbs and obstacles, whilst for work of vital national importance higher standards may be authorised by the chief officer of police.

In respect of processes requiring discrimination of detail the Committee explains that circumstances have prevented the investigation on a fundamental basis of the relation between fineness of work and the illumination required. Attention is directed, however, to the "Recommended Values"* issued by the Illuminating Engineering Society, the broad classifications of which are presented as an appendix to the Report.

SUITABILITY.

It is again emphasised that mere quantity of light provided is by no means the only factor in good lighting, and attention is drawn to the importance of reflection of light from surroundings in relieving the effects of the black out. Such surroundings (including the ceiling, walls, floors, benches, and interiors of blacked out windows and roof lights and, where possible, the plant) should therefore be maintained light in colour.

It is accordingly recommended that:—

(3) Throughout the interior parts, in which persons are regularly employed, walls, partitions, ceilings, tops of rooms, including interior surfaces of windows and roof lights through which the passage of daylight is continuously prevented, and as far as practicable, other structural fixtures, which are less than 20 ft. above floor level, shall be maintained light in colour.

Here again there are certain classes of factories (e.g., blast furnaces, parts of chemical works and tar distilleries) where the application of this recommendation would be inappropriate. It is suggested that the Chief Inspector of Factories be empowered to grant exemption in such cases.

* Issued by the Ministry of Labour and National Service, obtainable from H.M. Stationery Office, 3d. net.

* Transactions of Illuminating Engineering Society (London), November, 1938.

Suppression of Glare.

Glare is still prevalent in many factories, especially those in which antiquated systems of lighting are in use. The Committee therefore sees no reason to modify its previous recommendations, which ran as follows:—

(4) Where any light source in a factory is less than 16 ft. height above floor level, no part of the source or fitting having a brightness greater than 10 candles per square inch shall be visible to any person whilst normally employed within 100 feet of the source, unless the angle of elevation from the eye to the source exceeds 20°.

(5) All local light sources in a factory shall be provided with suitable shades of opaque material or other effective means by which they shall be completely screened from the eyes of every person employed at a normal working place.

(6) Adequate means shall be provided as far as reasonably practicable by suitable screening or placing or other effective method to prevent discomfort or injury by the reflection of light from smooth or polished surfaces into the eyes of the worker.

Whilst confining its recommendations in (4) to sources mounted at heights below 16 feet, which should serve to eliminate serious cases of glare, the Committee desires to emphasise that some care is necessary in the case of sources mounted at a higher level. Even in these circumstances the use of brilliant unscreened sources is preferably avoided.

Avoidance of Shadows.

It appears that there are still cases in which troublesome shadows occur. It is suggested therefore that the former recommendation should be retained. It runs as follows:—

(7) Adequate means shall be taken, as far as reasonably practicable, to prevent formation of shadows which interfere with the safety of, or cause discomfort to, any person employed.

Under present conditions there appears little risk of flickering light sources, and it is suggested that the previous recommendation on this subject need not be pursued. On the other hand, it is remarked that the so-called system of complementary lighting (i.e., the use of sodium discharge lamps or tungsten filament lamps in amber bulbs, in conjunction with blue windows) is often open to objection, and has been to a great extent abandoned. It is recommended that its adoption should be discouraged in future. (No objection is taken to the use of sodium discharge lamps *per se*.)

Natural Lighting.

It is generally recognised that some method of enabling natural light to be admitted during daytime is very desirable. A supply of natural light, even in small quantities, is an important factor in contributing to the cheerful appearance of a workroom. This object can be secured by the provision of shutters or blinds enabling part of the roof windows to be unobscured during the day. In the average roof-lighted factory uncovering of the windows to the extent of 12 per cent. of the floor area, so as to allow a reasonably uniform distribution of daylight, is generally sufficient to enable work to be done without recourse to artificial light, but even a smaller admission is of considerable benefit. In regard to side windows, there is a tendency to remove the obscuration from the lower portion of the window, leaving the upper part blackened. It is, therefore, pointed out that, from the standpoint of general lighting, the upper part is far the more effective in illuminating the interior of the room. In the absence of any special reason to the contrary, therefore, this portion should preferably be left obscured. A final allusion is made to a method of lighting, now being studied by the Industrial Health Research Board, whereby light approximating in colour to daylight is so distributed as to give the effect of emanating from windows.

Conclusion.

It has been strongly urged by witnesses that the above recommendations should be given statutory force. Attention is, however, drawn to a possible shortage of equipment. Whilst present stocks of lighting appliances and accessories are more than sufficient for normal demands, a very large number of factories is affected. It is, therefore, suggested that compliance with the new standard might not be pressed for the present in factories not engaged in work of primary importance provided that existing conditions are reasonably satisfactory. Compliance with the old standard of 1 ft.c. at floor level, together with absence of excessive glare, might be accepted as a rough criterion.

In other factories the importance of good artificial lighting clearly varies directly with the length of time worked under it, and attention should first be directed to those in which overtime or shifts are worked, especially when combined with a system of total obscuration of natural light.

It is pointed out that expert advice and supervision will be required in most factories if the best results are to be obtained. It has been represented that qualified illuminating engineers, who number about 200 in all, might, if over an appropriate age, be included amongst those in reserved occupations.

In conclusion, the Committee records with great regret the death of one of the members of the Committee, Dr. R. J. Lythgoe, and refers to the loss of the valuable assistance of Dr. H. Hartridge owing to other urgent work. High appreciation is expressed of the valuable services rendered by the Secretary (Mr. R. W. Daniel).

Ventilation for Buildings in Conditions of Black-out

It will be recalled that some little time ago (March, 1940, pp. 42-3) we reviewed the revised and extended version of BS/ARP 15, dealing with light locks at entrances to buildings, in which the applications of the original device were shown to be considerably extended.

As we go to press we have before us another very serviceable specification entitled "Ventilation for Buildings in Conditions of Black-out (BS/ARP 31)",* This presents a number of methods of solving the problem of affording ventilation in factory buildings without allowing any material escape of light. Such a specification is obviously of great value at the present time, when black-out methods, hastily improvised after the outbreak of war, are being reviewed and replaced by more workmanlike and scientifically planned devices.

The substance of the specification is naturally located mainly in the illustrations, eleven in number, some of which we hope to reproduce in a forthcoming issue. The forms of light traps shown are adapted to windows of various types, to transom lights over doors, for wall openings, and to roofs. A special ventilator light trap for wall openings, used in conjunction with propeller fans, is also illustrated.

It is instructive to observe how all these devices really embody the fundamental principles of light traps set out in the earlier specification, and in what a variety of forms this principle is now being applied.

* British Standard Specification BS/ARP. 31, published by The British Standards Institution, 28, Victoria-street, London, S.W.1. Price 6d. Post free 8d.

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Literature on Lighting

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

(Continued from page 100, June, 1940.)

III.—SOURCES OF LIGHT

144. Tungsten Filament General Service Electric Lamps.

British Standard Specification, No. 161, June, 1940.

This is the ninth revision of this specification, which appeared originally in 1921. There are six sections dealing with Definitions, General Procedure, Requirements, Selection of Lamps for Test, Conditions of Test and Rejection. Schedules for single coil and coiled coil lamps are presented and further details given in appendices. Modifications in procedure for determining average efficiency, reducing the amount of photometry required, are now made and some revision in regard to low voltage coiled coil lamps is noted. J. S. D.

145. The Fluorescent Mazda Daylight Lamp.

A. H. Taylor. Magazine of Light, IX., No. 3, pp. 11-12, April, 1940.

A comparison of the quality of the light from daylight fluorescent lamps with natural daylight is made. Data are given on the average colour temperature of daylight for various seasons, and weather conditions. C. A. M.

146. Complete Line of Drying Lamps.

C. W. Maedje. Magazine of Light, IX., No. 3, pp. 16-17, April, 1940.

Details with photographs are given of a set of incandescent lamps designed for paint drying. In one case a reflecting finish is added to the inside of the bulb. C. A. M.

147. High Wattage Mercury Arcs.

J. W. Marden, N. C. Beese, G. Meister. Am. Illum. Eng. Soc. Trans., 5, pp. 458-462, May, 1940.

A description is given of the construction and performance of two water-cooled mercury arc lamps, having a length of 30.5 cm. and inner diam. of 2 mm. The effect on light output and life given by dissipations of 6,000 to 10,000 volt-amperes is described, and the possibility of higher power is discussed. J. S. S.

IV.—LIGHTING EQUIPMENT

148. Recommended Practice for the Illumination Performance of Residential Ceiling Luminaires.

Anon. Am. Illum. Eng. Soc. Trans., 6, pp. 523-526, June, 1940.

A specification is given for the types and illumination requirements of fittings for the general lighting of domestic interiors. It is pointed out that such general lighting should be supplemented by local lighting. J. S. S.

149. Some Engineering Aspects of Headlighting.

H. H. Madsick. Am. Illum. Eng. Soc. Trans., 6, pp. 533-543, June, 1940.

A record is given of the experimental work leading to the design of the "Sealed Beam" headlight. J. S. S.

150. Specification of Optical Requirements of Electric Headlamps of the Sealed Beam Type for Motor Vehicles.

Anon. Am. Illum. Eng. Soc. Trans., 5, pp. 444-446. May, 1940.

The official specification for the testing of "Sealed Beam" headlights is given.

151. Directional Flashing for Motor Vehicle Signals.

P. H. Chase. Am. Illum. Eng. Soc. Trans., 5, pp. 417-430, May, 1940.

The requirements for an effective direction-indicating signal are discussed, and the design of a signal giving a "running" sign effect is described. It is concluded that an effective indication is given irrespective of the position on the vehicle, and uncombined with any arrow or indicating shape. J. S. S.

V.—APPLICATIONS OF LIGHT

152. Light and Architecture.

Anon. Am. Illum. Eng. Soc. Trans., 5, pp. 411-415, May, 1940; 6, pp. 497-502, June, 1940.

Some representative architectural lighting schemes are described with photographs. J. S. S.

153. Illumination Designed for Buying in Self-service Food Stores.

G. Gillard. Am. Illum. Eng. Soc. Trans., 6, pp. 503-513, June, 1940.

The majority of visual tasks in self-service food stores call for high illumination on a vertical plane. Light distribution curves for various methods of obtaining such illumination are given, but it is said that suitable equipment is not readily available. J. S. S.

154. A Study of Chalkboard Visibility.

W. G. Darley, L. S. Ickis. Am. Illum. Eng. Soc. Trans., 5, pp. 431-443, May, 1940.

Data, obtained with Luckeish Visibility Meter, are presented on the relative visibility of different types of chalk on a range of different chalkboards. J. S. S.

155. Drafting-room Lighting.

C. L. Amick. Magazine of Light, IX., No. 3, pp. 18-21. April, 1940.

Three new systems of drawing office lighting are described. In one silvered bowl incandescent lamps in louvred fittings are used, mounted close to the ceiling. In a second installation silvered bowl lamps and fittings are recessed in rectangular coffers in the ceiling. In the third installation the entire ceiling is fitted with continuous troughing in which fluorescent lamps are installed. In this third installation the resulting illumination values range between 65 and 103 ft.c. C. A. M.

156. Modern Lighting for Modern Banking.

W. J. Burton, Magazine of Light, IX., No. 3, pp. 24-25. April, 1940.

Details with photographs are given of a new installation of tubular fluorescent lamps in a bank in North Carolina. An average illumination value of 75 ft.c. has been obtained. C. A. M.

157. Factory Lighting.

Anon. Elect., 124, p. 454. June 28, 1940.

Some details with a photograph are given of a factory lighting installation covering nearly 15,000 sq. ft. on one floor. Illumination values of 18 to 20 ft.c. were measured on the working plane. C. A. M.

158. Daytime Lighting in Blacked-out Factories.

R. Maxted and J. Bertram. El. Times, 97, pp. 481-483. June 6, 1940.

An illustrated account of some installations of tubular fluorescent lamps in which artificial skylights and windows were used extensively. W. R. S.

159. Lighting for Night Sports.

R. J. Swackhamer, G. G. Bobst. Am. Illum. Eng. Soc. Trans., 5, pp. 447-457. May, 1940.

The design of lighting installations for baseball, football, and other sports is discussed in detail. J. S. S.

160. New Sports Floodlight.

Anon. G. E. Rev., 6, p. 265. June, 1940.

A new floodlight, using Alzaba reflectors, giving narrow or wide beams, is described. 750-watt, 1,000-watt, or 1,500-watt lamps may be used. J. S. S.

161. New Zealand Centennial Exhibition.

Anon. El. Rev., Vol. CXXVI., No. 3,265, p. 660. June 21, 1940.

Nearly a mile of fluorescent tubing was used for the lighting display at the New Zealand Centennial Exhibition. Difficulties attending the lighting of some of the exhibition buildings were successfully overcome. R. G. H.

162. Luminous Advertising.

C. M. Cutler. Magazine of Light, IX., No. 3, p. 38. April, 1940.

Details with a diagram are given of the application of tubular fluorescent lamps to facia lighting of stores. C. A. M.

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163. Applications of Tubular Fluorescent Lamps.

C. E. Weitz. Magazine of Light, IX., No. 3, pp. 33-37. April, 1940.

Numerous photographs with details are given of the use of tubular fluorescent lamps in the lighting of stores, restaurants, and offices. C. A. M.

VI.—MISCELLANEOUS

164. Road Surface Texture Prints.

Anon. Nature, Vol. 145, No. 3,662, p. 40. Jan. 6, 1940.

A few square inches of road surface under examination are cleaned of dust and carefully inked over with a water letterpress ink. A clean rubber roller is run over the inked area and the impression transferred to white paper. The prints so obtained are remarkable for the amount of detail which they exhibit. R. G. H.

165. Applications of Photography to Engineering.

A. H. Styring. Nature, Vol. 145, No. 3,662, p. 39. Jan. 6, 1940.

A summary is given of several practical applications of infra-red photography, photography by polarised light, X-ray photography, and high-speed photography. R. G. H.

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Personal

We learn that Mr. R. Gillespie Williams, late general sales manager of Holophane, Ltd., has now joined Messrs W. J. Furse and Co., Ltd., of Nottingham, London, and Manchester. It will be recalled that Mr. Gillespie Williams has devoted special attention to theatre lighting control equipment and colour lighting of all kinds, with which we understand he will continue to be concerned in his new position.

THE NATIONAL PHYSICAL LABORATORY

Daylight Illumination

The attention of the Department of Scientific and Industrial Research has been called to apparent differences in the findings of Illumination Research Technical Papers Nos. 7, 12, and 19, and it has been asked whether these differences can be reconciled, or whether No. 19 supersedes the earlier papers Nos. 7 and 12.

It may be recalled that Paper No. 7 (Penetration of Daylight and Sunlight into Buildings), which was first published in 1927, is largely concerned with the calculation of daylight factors, and a "minimum tolerable" value of daylight factor of 0.2 per cent. is proposed. Substantially the Illumination Research Committee, in publishing this paper, endorsed the views expressed by one man with long experience of illumination problems. It is made clear that a higher standard is required for certain purposes; for instance, a daylight factor of 0.5 per cent. is mentioned as that on the worst desk of approved elementary school class rooms.

Paper No. 12 (the Daylight Illumination required in Offices), issued in 1931, gives the views of a "jury" composed of architects, illuminating engineers, an accommodation officer of H.M.O.W., and an engineer, on the minimum tolerable daylight factor for a number of rooms of various shapes and sizes; the view of the occupier of each room was also obtained. The value reached was substantially 0.2 per cent. These rooms were used for ordinary writing.

Some misapprehension has arisen from a wrongly worded sentence in this paper. The "jury," of which the author of the paper was not a member, were investigating minimum tolerable values of daylight, and did not express the view that natural lighting in a clerical office may be regarded as adequate where the daylight factor is equal to or exceeds 0.2 per cent. It is noteworthy that such a view was expressly rejected by the International Commission on Illumination when it discussed problems of interior illumination in the same year.

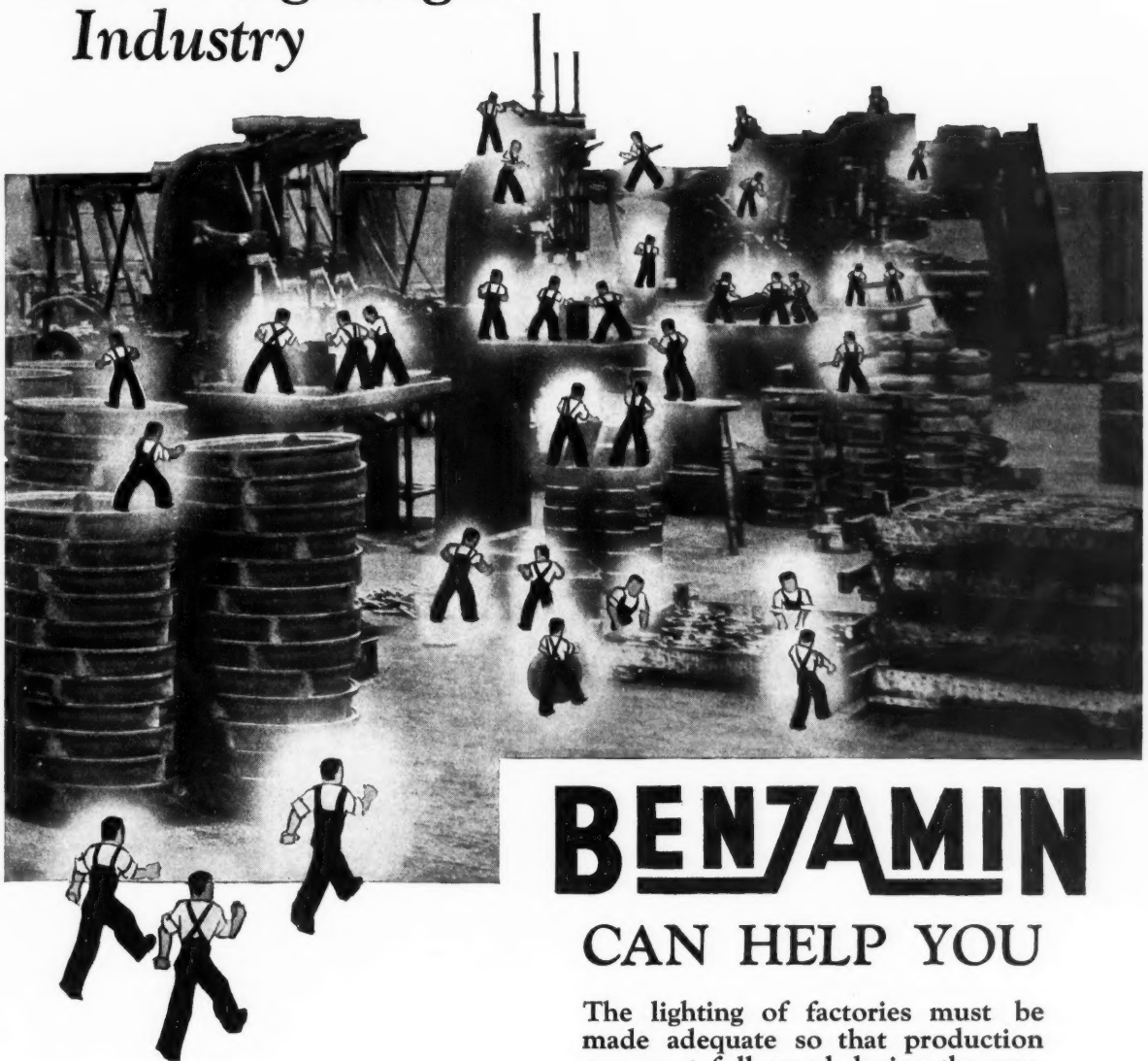
The investigation of 1937 described in Paper No. 19 (Daylight Illumination Necessary for Clerical Work) differed from the other two in that the workers themselves in the normal course of their duties provided—perhaps unconsciously—the data on which the conclusions were based. The value reached—5 ft.c.—corresponds to a daylight factor of 1.0 per cent. on a dull day when the outside illumination is 500 ft.c. The work concerned was typewriting, and this word could with advantage have replaced clerical work in the title. In view of references in the paper to artificial illumination it may be well to state definitely that the conclusions reached in the investigation related to daylight.

It is probably fair to say that in the first two investigations the emphasis has tended to be on illumination that is inadequate for clerical work and other purposes that may be classified as stationary, and in the third on illumination needed to carry through typewriting and other rapid operations efficiently. As might be expected, the personal factors, as revealed in the second and third papers, are rather large, but there is no reason to suppose that the third misrepresents the standard of illumination that should be secured for typewriting and similar work. Such operations necessitate a higher minimum of illumination than comparatively slow processes such as handwriting. It is not surprising that the standard of illumination generally expected—and now easily obtained—has risen. The position was summarised concisely in the chairman's prefatory note to the last of these papers—"Some of the minimum standards of illumination suggested in the past are much too low." This, of course, does not imply that there are no conditions for which a lower standard of illumination than is necessary for efficient typewriting is adequate. Much more work, preferably on a scale large in comparison with the investigations made hitherto, is needed before we are entitled to suppose that our knowledge of these problems is sufficient for practical needs.

T. Smith.

(Superintendent, Light Department, National Physical Laboratory.)

The Government Require Better Lighting in Industry



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A Flashing Lamp of Simple Design

by

A. J. Maddock, M.Sc., F.Inst.P., A.M.I.E.E.

ABSTRACT. A simple type of flashing light is described of high luminous output in which the flashing characteristics are inherent in the lamp itself, no external switching or striking circuits being necessary. An example of such a tube is given which illustrates the method of operation and control obtainable.

1. General Principles.

The flashing light to be described* is one of very simple construction in which the flashing characteristics are inherent in the lamp itself, thus rendering unnecessary the use of contactors, switching gear, or other forms of control such as condenser charging circuits. The luminous output can be made very great and the lamp is suitable for flashing beacons at airports, coastal stations, airways, advertising, and the like.

The discharge tube contains one electron emitting electrode and one non-emitting electrode, a filling of an inert gas or gases at a few millimetres pressure to initiate a discharge between the electrodes and a metallic vapour to produce a high luminous output from the resulting arc set up by the initial gas discharge. An A.C. supply is connected to the electrodes through a suitable current limiting device such as a choke or resistance.

When the non-emitting electrode (the anode) becomes positive with respect to the emitting electrode (the cathode) a discharge takes place in the inert gas and this immediately initiates an arc of the metal vapour present in the tube with consequent high luminous output. At the end of each positive half cycle, however, the arc is extinguished since the anode is now negative. The passage of the arc through the tube raises the temperature considerably and hence the pressure of the inert gas is increased and, if the temperature rise is sufficient, the gas pressure will have increased so much that on the succeeding positive half cycles the applied A.C. voltage will be of too low a value to initiate the discharge again and it is only after the tube has cooled down somewhat that the gas pressure again reaches a value such that the available A.C. voltage can cause a discharge and hence an arc to flow between the electrodes.

Thus the flashing is caused by the fact that the arc raises the gas pressure outside the region where the available A.C. voltage can initiate a discharge in the gas and a period of no light output is obtained during the time the tube takes to cool down to allow striking to occur again. It is thus apparent that for a large current the temperature rise will be so great that the flash will consist of only a part of one half cycle whilst the dark period may be of many seconds duration. Alternatively, for a small current the temperature will rise slowly and the arc will pass for several succeeding positive half cycles before the gas pressure rises beyond the point where the voltage is insufficient to cause a discharge. The duration of flash is thus controlled by the value of current and by the dimensions of the tube, and these factors also control the rate of flashing. Thus, for a given tube the flashing rate will decrease as the current increases, whilst for the same current a smaller tube will flash at a slower rate than a larger tube since the temperature rise will be greater.

In general, with tubes of high luminous output, the flash is of the order of one quarter cycle in duration (i.e. on a 50 c.p.s. supply of the order of 0.005 seconds) since initiation occurs at the peak of the A.C. voltage wave. The rate of flashing can be varied over wide limits by suitable choice of dimensions for the tube and, for a given tube, considerable latitude is possible in this direction by adjustment of the current passed through the tube. Since the period of current flow is so short compared with the intervals between flashes, current carrying leads and stabilising devices such as chokes or resistances may be of small capacity relative to the momentary current during flashes. It has been found satisfactory to rate these for about one-fifth of the momentary current.

The flashing rate is made more regular and independent of wide changes of external temperature by having an outer envelope surrounding the discharge tube which may be evacuated or filled with a gas. Where accurate timing of the flashes is required the temperature of this outer envelope may be controlled by some thermostatic device or the temperature of the air surrounding the whole tube may be similarly controlled. However, since the flashing rate can be varied by change of the momentary value of the current, the stabilising choke or resistance can be made variable so that gradual changes of ambient temperature may be compensated for with but little

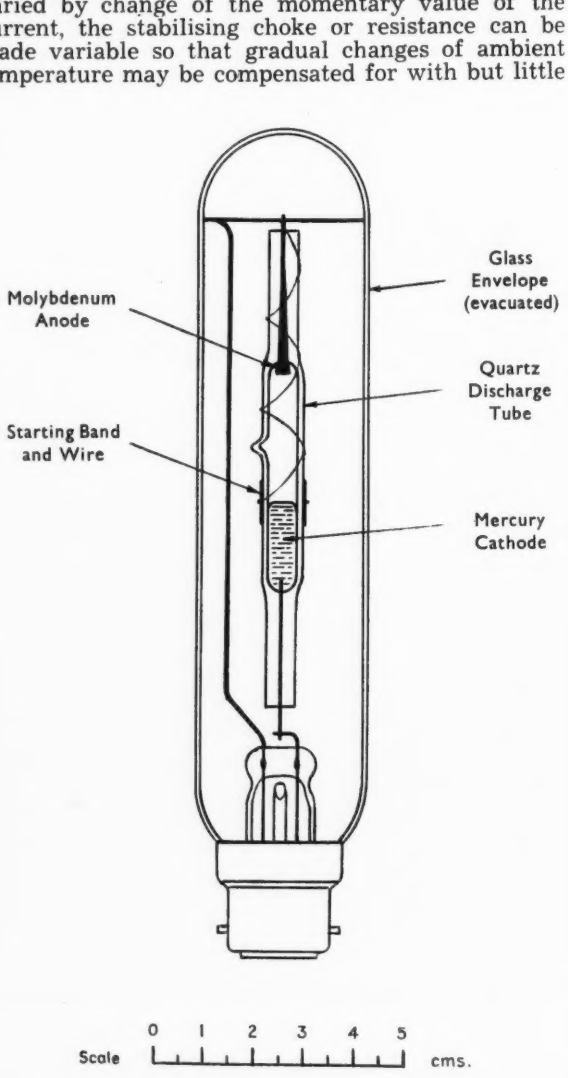


Fig. 1. Design of simple Flashing Lamp.

* Patent applied for.

change in the luminous output. Incidentally the glass envelope also acts as a filter to cut off the strong ultra-violet radiation that is emitted from a tube made of fused quartz.

2. Example and Results Obtained.

An example of a simple tube constructed on the above lines is shown in Fig. 1. It consists of the discharge tube made of fused quartz having a molybdenum anode and mercury pool cathode and containing a mixture of argon and neon at pressures of 16 mm. and 28 mm. respectively: this pressure gives a low striking voltage which is further aided by the external metallic band around the tube near the cathode but in metallic connection with the anode. The outer glass envelope is evacuated. Fig. 2 shows the results obtained on this particular tube when operated on a 250 volt A.C. supply with and without the outer evacuated envelope; this latter reduces the rate of flashing, of course, since the rate of cooling is reduced. A momentary current of 30 amps. gave a flashing rate of about thirty flashes per minute for this particular tube and the luminous output during the flash was very high. Much greater momentary currents, of the order of hundreds of amperes, are envisaged for really intense sources of light.

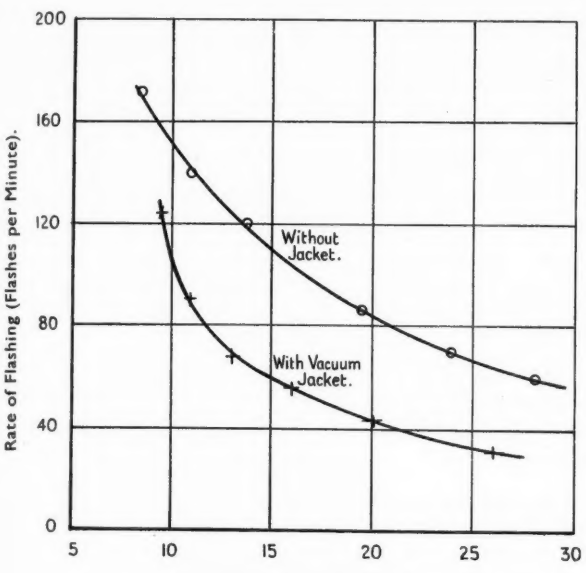
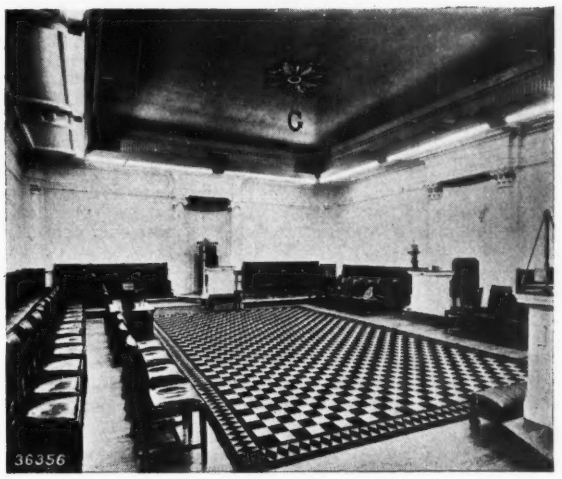


Fig. 2. Characteristics of the Flashing Lamp of Fig. 1.

There is a tendency, in the simple tube having a mercury pool cathode, for anode material to be sputtered on the cathode surface resulting in the constancy of flashing rate being impaired after a long period of running. Improvements, however, are possible to overcome this such as making the cathode of the self-heating type or a coated cathode heated by a low voltage alternating current, the tube containing a small globule of mercury and an inert gas filling such as argon. The luminous output may be still further increased by arranging a heating coil around the tube so that the vapour pressure of the metal is increased; in this case the initial pressure of the inert gas (i.e. the pressure when the tube is first filled in the cold state) is kept low so that during normal running of the tube the arc strikes when the tube has cooled to the temperature determined by the surrounding heater.

The author desires to thank the Thermal Syndicate, Ltd., in whose laboratories this investigation was carried out, for permission to publish this paper.

Fluorescent Lighting in Edgbaston Assembly Rooms



A view of Masonic Temple at Edgbaston Assembly Rooms, lighted by fluorescent tubular lamps.

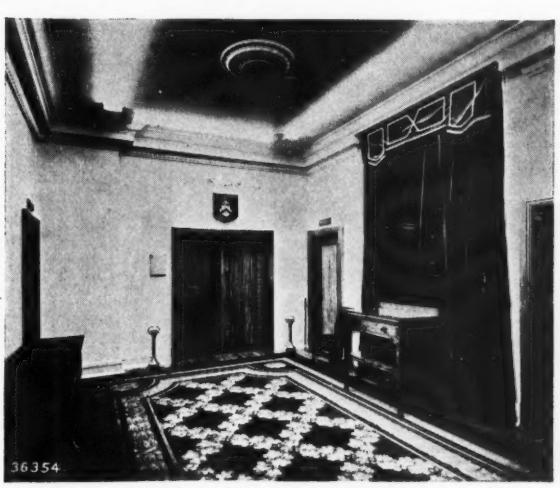
We illustrate in this column some views of the Edgbaston Assembly Rooms, in which Mazda fluorescent lamps have been adopted on a large scale.

According to information supplied by the British Thomson-Houston Company, Ltd., nearly 3,000 ft. of tubing have been used in this building. There are over fifty circuits spread over seventeen rooms, corridors, and staircases. Besides the two rooms illustrated, there are dining and reception rooms, ballroom, lounge, etc., in all of which the same system was adopted. In the large dining room approximately 480 ft. of tubing are used.

The special qualities of these new lamps have been recently mentioned in "Light and Lighting." For many industrial situations—especially where, owing to black-out conditions, a mixture of daylight and artificial light is found throughout the day—they seem to have special value.

It has, however, been a matter for speculation how far this "white light" can be adopted for decorative interior lighting. In this instance the system appears to have proved very acceptable. It is also noteworthy that its introduction led to a substantial saving (£182 per annum) in total operating cost, as compared with an installation of tungsten filament lamps producing the same amount of light.

The contractors for the installation were Walker Bros., of Birmingham.



The same system of lighting applied to the ante-room at the Edgbaston Assembly Rooms, where a triple run of lamps encircles the room.

Gas Lighting Calculations

In a recent contribution to Industrial Gas (July 20) Mr. W. J. G. Davey emphasises the higher illumination necessary for precision munitions work, as compared with ordinary industrial operations, and gives a table showing how the requisite gas consumption corresponding to any prescribed illumination may be calculated. According to a familiar empirical formula the number of British thermal units required per hour is obtained by multiplying the illumination in foot-candles by four times the area to be illuminated. (Thus, if 10 ft.-c. is to be provided, 40 B.Th.U's will be required per sq. ft., and 25 hours of lighting over 100 sq. ft. can be obtained for 1 therm.) The number of lamps required may also be ascertained roughly by means of the formula $N=A/4H^2$, where N is the minimum number of lamps, A the area in square feet, and H the height of suspension. This assumes an approximately square room and a spacing-height ratio of 2:1.

The Illuminating Engineering Society (U.S.A.)

Notes on Transactions (July, 1940)

NEWS: At a meeting of the Council on June 13 the President (Mr. Lester H. Graves) was authorised to offer the services of the Society to the Government in the furtherance of the *programme of National Defence*. The offer was conveyed to the President of the United States, and the appointment of a suitable committee suggested. In a report by Mr. E. R. Sherbaum, electrical engineer to the New Jersey State Highway Department, data are quoted showing the diminution in *night accidents on roadways* on which improved lighting had been installed.

A report of Mr. W. Kimbel, chairman of the Advisory Board of Design of the American Lighting Equipment Association, pleads for more recognition of *the human factor in residential lighting practice*. The New York Giants baseball club have played their first home game by artificial light on a ground receiving 200 millions candle-power from 836 floodlights mounted 150 feet high. *Statistical studies of vision* in New York show that of 200,000 children 20 per cent. suffered from eye faults. In industry percentages of faulty vision vary from 15-20 in the cement, foundry, cigar, and pottery industries to 40-60 per cent. in post-office, gas, chemical, and garment industries. In certain cases up to 75 per cent. has been recorded.

CONTRIBUTIONS: *Heating Hotbeds with Radiant Energy from Incandescent Lamps*, by R. L. Zahour. Electrically heated hotbeds have been developed during the last decade. Electric heating has definite advantages over manure, notably in ease of control. The heat has previously been applied by means of cables buried in the soil, but the author has had good results from the use of rows of incandescent lamps attached to the frames, and considers this method preferable. Full descriptions of such devices and records of results, including comparative cost of methods based on the use of manure, electric cables, and incandescent lamps, are presented. *The Measurement of Sight*, by L. H. Hardy. The author points out that such measurements involve tests of a variety of factors. Conventional tests of visual acuity based on the observation of type do not cover ability to perceive differences in light intensity and quality, to perceive the presence of objects, to discriminate form, to appreciate depth, and to see quickly and to see peripherally. Tests of vision should take consideration of these factors with due regard to the specific purpose of the test. *Influence of Fluorescent Lighting on the Colours of Decorations and Furnishings*, by A. H. Taylor. The new fluorescent lamps are of great interest to decorators. The author presents diagrams comparing the distribution of light in their spectrum with that of daylight. Supplementary observations of panels, executed in various colours and illuminated by these two sources of light, confirm the close resemblance. *A Device for the Determination of Illumination*, by B. F. Greenburg. The author recalls that formulae, graphs, and scales have been devised to enable the resultant illumination at any point from a source of extensive and irregular luminous area to be calculated. The method he now describes is based on the application of a series of scales, printed on celluloid, to a scale drawing of the source. Numerical examples showing the application of the method and the time required (3 to 7 minutes) are given.

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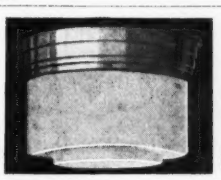

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Index to "Where to Buy"

Accessories	22
Architectural Lighting	6, 12, 13, 17, 24, 25
Automatic Light Control	11, 15, 20
Cinema Lighting	6, 13, 14, 19, 21, 25
Concrete Pillars, etc.	5
Electric Lamps	4, 21
Fittings	2, 3, 4, 7, 8, 9, 12, 13, 14, 16, 17, 18, 19, 21, 24, 25, 26, 27, 28
Floodlighting	2, 4, 9, 14, 21, 25
Gaslighting	16, 26
Glassware	14
Industrial Lighting	3, 4, 6, 8, 9, 12, 13, 18, 21, 28
Local Lighting	18
Photo Electric Cells	20
Photometers	1, 10
Reflectors	3, 4, 7, 8, 9, 14, 21, 24, 27
Signal Lights	28
Special Lighting	2, 6, 9, 12, 13, 14, 17, 19, 21, 24
Street Lighting Units	4, 7, 8, 9, 14, 16, 21, 26
Theatre Lighting	2, 14, 21, 25
Time Switches	11, 15
Winches and Suspension Gear	23

N.B.—The numbers are those attached to individual entries in the Directory (See pp. 135—136)

940

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22
25
20
25
5
21
28
25
26
14
28
18
20
10
27
28
24
26
25
15
23